DRAFT

RED DOG OPERATIONS ALASKA

Fugitive Dust Risk Management

Remediation Plan

Teck

July 2011

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Acronyms and Abbreviations

CoPCs	chemicals of potential concern
CSB	concentrate storage building
DEC	Alaska Department of Environmental Conservation
DMTS	DeLong Mountain Regional Transportation System
MOU	Fugitive Dust Memorandum of Understanding
RMP	risk management plan
SEIS	supplemental environmental impact statement
SOP	Standard Operating Procedures

Executive Summary

In August 2008, a draft risk management plan (RMP) was released as part of a process intended to minimize risks associated with fugitive dust emissions from operations at Red Dog Mine (Exponent 2008). The RMP combines and builds upon prior and ongoing efforts by Teck to reduce dust emissions and incorporates stakeholder input obtained during a 3-day risk management workshop held in Kotzebue, Alaska, in March 2008 (Teck Cominco 2008). The RMP describes seven fundamental risk management objectives that address the overall goal of minimizing risk to human health and the environment, identifies and evaluates risk management options to achieve those objectives, and describes a process for developing implementation plans to achieve the fundamental objectives. Part of that process is the development of six individual risk management implementation plans that describe more specifically how the fundamental objectives will be met. This document presents one of those implementation plans, the Red Dog fugitive dust remediation plan (remediation plan).

Preparation of a remediation plan follows from risk management Objective 2, *Continue remediation or reclamation of selected areas to reduce human and ecological exposure*. In order to achieve this objective, the remediation plan was developed with the following goal:

- To define a consistent method for identifying and selecting affected areas and implementing remediation and/or reclamation.

This plan includes a review of past, ongoing, and potential future actions, and selects a set of remediation actions designed to accomplish the goals and objectives of the remediation plan.

Review of Past, Ongoing, and Potential Future Actions—Review of past and ongoing remediation actions carried out as part of Red Dog environmental operations provides an opportunity to take stock of diverse efforts already taking place, evaluate what actions work well, and identify ways to improve future efforts. The review of potential future actions includes those actions established during the RMP development process, such as additional remediation actions suggested by various stakeholder groups.

Selection of Remediation Actions—Based on the review, the range of possible remediation actions were evaluated to select the most appropriate set of actions. The remediation plan addresses the following categories of actions:

- Spill Response: Lead and zinc concentrates are the primary materials that would trigger immediate cleanup actions if spilled onto land or into water. Spill cleanup methods are described in various Red Dog standard operating procedures. Following spills in the tundra area, revegetation will be implemented where appropriate.
- Threshold-based Remediation in Operational Areas: Remediation through removal and recycling or treatment to minimize further releases of CoPCs to the surrounding environment will be triggered in operational areas by results of road surface monitoring. Remediation of road and pad areas will typically involve reclaiming the surface materials and replacing them with new, clean materials.
- Remediation Conducted at Mine Closure: Remediation of areas within the mine boundary at the time of mine closure is not part of this plan, but rather is covered separately in the reclamation and closure plan (Teck 2009).
- Monitoring of Remediated Areas: Monitoring will be conducted to ensure that revegetation efforts are successful in remediated tundra areas.
- Remediation and Reclamation Research: A variety of studies will be considered to improve understanding and effectiveness of tundra remediation. Studies may include evaluation of additional methods of tundra remediation, and research to improve our understanding of the nature and timing of natural tundra recovery after metals dust deposition has been decreased.

Additional details regarding these planned remediation actions are provided in this document, along with details of plan implementation, communication and collaboration tools to be used, periodic review and reporting, milestones for completion and review of the plan, and stakeholder involvement in the plan.

1 Introduction

This remediation plan is an implementation plan associated with the fugitive dust risk management plan (RMP). The RMP was developed to combine and build upon prior and ongoing efforts by Teck Alaska Incorporated (Teck) to reduce dust emissions and minimize potential effects to human health and the environment. The RMP addresses issues identified by several different studies and programs, including the DeLong Mountain Regional Transportation System (DMTS) risk assessment (Exponent 2007a,b), the mine-area ecological risk evaluation conducted as part of the mine closure and reclamation planning process (Exponent 2007c), the Fugitive Dust Memorandum of Understanding (MOU) between the Alaska Department of Environmental Conservation (DEC) and Teck (DEC 2007), and the draft Supplemental Environmental Impact Statement (SEIS) for the Aqqaluk pit extension (www.reddogseis.com). The RMP also incorporates stakeholder input obtained during a 3-day risk management workshop held in Kotzebue, Alaska, in March 2008 (Teck Cominco 2008).

The RMP describes seven fundamental risk management objectives that address the overall goal of minimizing risk to human health and the environment surrounding the mine, road, and port, over the life of the mine and post-closure operation. The RMP also identifies and evaluates risk management options to achieve those objectives, and describes a process for developing implementation plans to achieve the seven fundamental objectives. This remediation plan is one of six individual risk management implementation plans that were identified in the RMP to address these objectives. The other five implementation plans are:

- Communication plan
- Dust emissions reduction plan
- Monitoring plan
- Uncertainty reduction plan
- Worker dust protection plan.

This document presents the remediation plan. The remainder of this document is organized as follows:

- Section 2. Goal of the Remediation Plan
- Section 3. Summary of Past, Ongoing, and Potential Future Remediation Actions
- Section 4. Actions to be Implemented
- Section 5. Periodic Review and Reporting
- Section 6. Milestones
- Section 7. Stakeholder Roles
- Section 8. References.

2 Goal of the Remediation Plan

The overall goal of the RMP is to minimize risks associated with fugitive dust emissions from Red Dog Mine operations. This remediation plan follows from risk management Objective 2 of the RMP, "Continue remediation or reclamation of selected areas to reduce human and ecological exposure." The purpose of this activity is to remove source materials that have elevated metals concentrations, so as to reduce direct human and ecological exposures, and to reduce the emissions of metals-bearing dust into the surrounding environment. In order to achieve this objective, the goal developed in the RMP (Exponent 2008) for the remediation plan is:

- To define a consistent method for identifying and selecting affected areas and implementing remediation and/or reclamation.[1]

This document is intended to fulfill this goal, and thus also fundamental risk management Objective 2, thereby helping to achieve the overall goal of the RMP by reducing human and ecological exposure to elevated metals concentrations and by reducing metals dust emissions into the environment.

[1] Objective 2 has changed slightly from the Draft RMP. Objective 2 in the Draft RMP is, "Continue remediation or reclamation of selected areas." This will also be clarified in the final RMP.

3 Review of Past, Ongoing, and Potential Future Remediation Actions

3.1 Evaluation of Past and Ongoing Actions

Teck Alaska has been implementing remediation and reclamation of localized areas as necessary throughout the history of the mine. Examples of past remediation efforts include the following:

3.1.1 Historical Truck Spill Sites Delineation and Recovery

During the summers of 2002 and 2003, 32 historical haul truck concentrate spills were systematically assessed, following the procedures as described in the spill site characterization plan (Exponent 2002b). At 15 locations the sampling program identified spill-related metals concentrations that exceed State of Alaska Arctic Zone industrial cleanup levels (18 AAC 340). For the metals of concern these levels are: 800 mg/kg lead, 41,100 mg/kg zinc, and 110 mg/kg cadmium. General procedures for spill concentrate recovery and recycling were described in the concentrate recovery and recycling plan and associated addendum (Exponent 2002c, 2003b). The results of the follow-up efforts at former spill sites were presented in multiple documents and summarized in the DMTS RA (Exponent 2007).

Revegetation of remediated areas was implemented after verification samples confirmed that metals concentrations in the excavated area were below Arctic Zone cleanup levels. Sites within Cape Krusenstern National Monument (SP08 and SP25) were allowed to revegetate naturally without application of seed, fertilizer, or other non-indigenous materials. Revegetation efforts have generally been successful, although the plant community may better reflect the surrounding plant community when allowed to recolonize naturally rather than planting with seed mixes.

3.1.2 DMTS Port Site Remediation Actions

The DMTS port characterization identified areas within the port with elevated concentrations of lead and zinc. Characterization efforts included several sampling programs implemented between 2002 and 2005 to evaluate the extent of metals deposition in the vicinity of the DMTS port site, including road surfaces, gravel pad areas, and tundra areas surrounding the port facilities (Exponent 2003a, Teck Cominco 2003). Lead, zinc, and cadmium concentrations were characterized using a combination of field-portable x-ray fluorescence (XRF) detector sampling and laboratory sample analysis. The results showed a general correlation of elevated metals concentrations with facility areas, particularly the concentrate storage buildings (CSBs) and roads into and out of the truck unloading building, where tracking of metals concentrates occurred (Exponent 2003a).

From 2003 through 2008, the areas with the highest potential to act as sources of fugitive metals dust were reclaimed. Reclaimed areas consisted of roads, pads, and tundra areas with surface concentrations between 5,000 and 10,000 mg/kg lead. After materials with elevated lead, zinc, and cadmium concentrations were removed, confirmation samples were collected to ensure that the area was below industrial Arctic Zone cleanup levels. Reclaimed areas were excavated to approximately 1–2 ft below the vegetated mat or pad surface to ensure that no soils with elevated metals remained, and then backfilled with clean fill. The followings locations were reclaimed between 2003 and 2008:

- 2003: Gravel pad just adjacent the entrance of CSB 2, approximately 1 acre
- 2004: Tundra islands to the south of the CSB, approximately 0.8 acre
- 2005: Tundra island to the southwest of the CSBs, approximately 1.25 acres
- 2006: Gravel pad near the entrance of MS 2, approximately 0.5 acres
- 2007: Tundra island near the water treatment plant, approximately 0.7 acres
- 2008: Road surface along P-8 conveyor, approximately 0.3 acres.

3.1.3 DMTS Road Recovery and Resurfacing

Sampling was conducted to characterize metals concentrations in areas of the DMTS road that were planned for test paving, specifically, road surfaces in the port area and the first 5 miles of the road. Prior to paving the test section of the DMTS, areas of the road surface with metals concentrations exceeding Arctic Zone cleanup levels were identified and the road surface materials in those areas were removed and recycled into the mill at the mine.

Areas having road surface or road core sample concentrations exceeding the Arctic Zone soil cleanup levels were identified through sampling work described in the Supplemental Road Sampling and Surface Material Removal Verification Report (Exponent 2002a). Using graders, the road surface material was furrowed and loaded into truck trailers using front-end loaders. Loads were covered with tarps, transported to the mine, and recycled in accordance with the concentrate recovery and recycling plan (Exponent 2002c). Approximately 15,000 tons of materials were removed and transported to the mine for recycling.

3.1.4 Mine Site Characterization

This work was conducted by Teck Cominco to provide a general evaluation of historical and existing fugitive dust within the Red Dog Mine site (Teck Cominco 2005). Work included extensive tundra soil sampling conducted in 2003 and 2004, which confirmed elevated metals concentrations in areas downwind of the mine pit, facilities, and roads (Teck Cominco 2005).

3.1.5 Mine Area Vegetation Impact Treatment Assessment

In 2006, Teck initiated a 3-year study to determine the extent to which plant communities have been affected by dust, and identify potential treatment options for mitigating impacts (ABR 2009). The preliminary results of this impact assessment suggested that the primary causes of the observed vegetation impacts were deposition of acid-forming dust, input of iron sulfate and zinc sulfate from fugitive dust, and reduction of soil aluminum to soluble forms.

Accordingly, test plots were established within three assessment areas downwind of the mine facilities to evaluate treatment using dolomitic lime for promoting vegetation recovery in the affected areas. The plots were treated with lime in August 2006 to raise soil pH and decrease aluminum bioavailability to vegetation. In 2007, triple superphosphate was added to one block within each of the assessment areas. This treatment was intended to reduce the availability of lead for uptake by vegetation.

The effectiveness of the two treatments in improving soil conditions and promoting vegetation recovery in dust-affected areas was largely inconclusive. In the plots treated with lime, some increases in pH and reductions in aluminum concentrations were observed, although not significantly different from those measured in reference plots. Applying triple superphosphate did not significantly reduce lead levels in treated plots. Despite the lack of measurable improvements in soil characteristics, the preliminary vegetation response observed in the treatments, including colonization of mosses and lichens, suggests that soil surface conditions may have become more favorable for vegetation establishment over time. Although the measured increase in vascular cover was modest, these observations suggest that with continued evaluation, the treatments may prove to be effective in making soil surface conditions more favorable for vegetation (ABR 2009).

3.2 Potential Actions Identified in the Risk Management Planning Process

As part of the risk management workshop, stakeholder groups were asked to list and discuss potential actions for each of six risk management action categories, including remediation. The potential actions that were outlined and discussed at the Risk Management Workshop are listed in Table 1, along with the overall ranking they received in the RMP. The potential actions in Table 1 can be generally grouped as follows: remediation and reclamation, monitoring of remediated areas, communication and collaboration (including incorporation of traditional ecological knowledge), institutional controls (signage), and uncertainty reduction (further studies to evaluate additional remediation and reclamation technologies). The following sections develop the plan of action for ongoing remediation activities.

4 Actions to be Implemented

The overall goal of the RMP is to minimize risks associated with fugitive dust emissions from Red Dog Mine operations. In this section, specific remediation actions are defined to accomplish the goal of this remediation plan, which is "To define a consistent method for identifying and selecting affected areas and implementing remediation and/or reclamation," thereby helping to achieve the overall goal of the RMP by remediating areas with elevated metals concentrations to reduce metals dust emissions into the environment.

In order to achieve the goal set out for the plan, possible remediation actions were identified and evaluated to select the most appropriate set of actions. A summary of potential actions identified by stakeholders during the risk management workshop is provided in Table 1. A compilation of actions that have been carried out as part of past or ongoing programs and potential actions identified at the RMP workshop is provided in Table 2. These potential actions were then screened, resulting in a focused list available for use in developing the plan (Table 3). Table 3 includes rationale for those actions that are not retained in the remediation plan.

The remediation plan addresses the following categories of actions:

- Spill response
- Threshold-based remediation
- Remediation conducted at closure
- Monitoring of remediated areas
- Remediation and reclamation research
- Communication and collaboration.

Communication and collaboration actions available at each stage of the remediation program are summarized in Table 4. The specific actions selected to accomplish the goals of the remediation plan are summarized in Table 5, along with planned timelines for implementation.

Figure 1 illustrates important milestones in the development of this plan, and provides the specific communication actions to be implemented associated with this plan. The following sections describe the categories of actions to be implemented as part of this remediation plan.

4.1 Spill Response Remediation

Remediation will be conducted for spills of materials with the potential to become significant point sources of metal-bearing fugitive dust or water contaminants. In general, the response to a concentrate spill can be divided into two phases; the initial response and the final cleanup. The initial response occurs at the time of the spill and includes the initial stabilization of the site to minimize movement of the concentrate and the removal of as much spilled material as possible. The timing of the initial cleanup and remediation of the site is determined by the specific site conditions at the spill site. The final cleanup may be delayed for a period of time until the site conditions are suitable.

Lead and zinc concentrates are the primary materials that would trigger immediate cleanup actions if spilled onto land or into water, because they have very high concentrations (percent levels) of metals identified as chemicals of potential concern (CoPCs) in the DMTS risk assessment (Exponent 2007).

Concentrate spill cleanup methods are described in the following Red Dog standard operating procedures documents (SOPs): Concentrate Spill Site Delineation, Survey and Soil Sampling SOP, and Port Road Concentrate Spill Cleanup SOP. Other spill cleanup actions are described in Spill Cleanup SOP. These spill response remediation approaches will apply whether the area to be remediated is a facility area, road, gravel pad, stream, or tundra/vegetated environment.

Following cleanup of a spill in a tundra area, revegetation will be implemented where appropriate. In certain circumstances, sites will be allowed to revegetate naturally without application of seed, fertilizer or other non-indigenous materials (e.g., within Cape Krusenstern National Monument). Where revegetation is to be implemented, the seeding mixture and

technique to be applied for revegetating areas at the Mine and Port and along the Port Road will follow the methods described in the closure and reclamation plan (Teck 2009).

Affected areas will be remediated to the best practicable extent; at a minimum to meet the State of Alaska Arctic Zone industrial cleanup levels (e.g., 800 mg/kg for lead, 41,000 mg/kg for zinc, and 110 mg/kg for cadmium) (18 AAC 340)[2]. All spill response remediation actions will be reported to the appropriate agencies per the Red Dog External Spill Reporting SOP.

4.2 Threshold-Based Remediation

Threshold-based remediation will be triggered in operational areas by results of road surface monitoring, which is conducted every 2 months as described in the draft fugitive dust monitoring plan (Exponent 2009). Affected areas south of the "Y" intersection (by the Overburden Stockpile at the Red Dog mine site) will be remediated to meet the Arctic Zone industrial cleanup levels (18 AAC 340). Areas may be remediated by removal and recycling or treatment to minimize further releases of CoPCs to the surrounding environment (e.g., via fugitive dust emissions or surface water runoff). Remediation of road and pad areas will typically consist of excavation and recycling of the surface materials through the milling process. New, clean materials will be placed in the excavated areas. Remediation will be conducted as outlined in the above-mentioned SOPs.

Although gravel pad areas are not part of the monitoring program, any pad areas with concentrations above thresholds are likely to be addressed as part of delineating a road surface remediation action based on surface material concentrations. This is because elevated metals concentrations in pad areas would likely either be a result of spills (addressed in the prior section), or concentrate tracking by vehicles or equipment.

[2] The Alaska industrial cleanup levels are protective of human health based on the site-specific exposure scenarios described in DMTS HHRA. When the risk models developed for the HHRA are applied assuming site soil metals concentrations equal to the Alaska industrial cleanup levels, estimated risks are below DEC and EPA defined target levels

In outlying tundra areas and other sensitive habitats surrounding the DMTS, mine and port it will be preferable to avoid the habitat disturbance that would result from active remediation. A key goal of the risk management planning process is to prevent metals dust accumulation in outlying areas, so as to minimize the need for future active remediation in those areas. This is accomplished through comprehensive programs developed for the monitoring plan and dust emissions reduction plans. The monitoring plan was designed to ensure spatial coverage at the source, operational boundary, and regional scales, as well as temporal coverage with short- and long-term monitoring frequencies. If monitoring results indicate increasing metals concentrations, additional dust control measures will be implemented to address concerns. In addition, effects-based thresholds developed for ongoing and future research could be used for threshold based remediation if needed. Possible additional studies to evaluate effects thresholds, particularly for the plant community, will be discussed in the uncertainty reduction plan.

4.3 Remediation Conducted at Mine Closure

Areas within the drainage basin of the tailings pond, including the mine pits, waste stockpiles, tailings pond, roads, and pads will be remediated according to methods outlined in the reclamation and closure plan (Teck 2009). In most cases this will be accomplished by removal or isolation using cover systems, with reclaimed areas being monitored for effectiveness of the systems as described in that plan.

At the DMTS Port site, areas around the concentrate storage buildings, the conveyors, and the shiploader may also be remediated by isolation using cover, because the opportunity to recycle removed materials will no longer be available after closure of the mill.

4.4 Monitoring of Remediated Areas

Within the mine boundary, monitoring of remediation actions will be conducted according to the reclamation and closure plan (Teck 2009). Monitoring will also be conducted in remediated

tundra areas near the DMTS road and port facilities , to ensure that revegetation is successful in these reclaimed areas.

Monitoring Vegetation Success: Monitoring plans will be developed for each unit of interest specifically. The success of reclaimed and revegetated areas will be evaluated by measuring a number of parameters that are indicators of overall productivity and habitat quality.

Soil Properties: To assess the physical and chemical characteristics of reclaimed soils, samples will be collected at 2 to 10 centimeter depth for analysis. Parameters measured will include particle size, percent organic matter, carbon and sulfur, electrical conductivity (EC), cation exchange capacity (CEC), total and exchangeable nitrogen and phosphorous, and exchangeable potassium, sodium, calcium, and magnesium. Levels of micronutrient metals, including copper, zinc, iron, manganese, and boron also will be measured.

Plant Density and Survival: Plant density and survival will be measured only for transplanted species and to assess percent germination and survival in test plots. Density will be measured in one square-meter plots, or within belt transects, depending on the size of the assessment area.

Plant Cover and Taxonomic Richness: For most areas, plant cover will be measured along transects using the point-intercept method: plant species are recorded intersecting points at 0.5–1.0 meter intervals delineated along a 50 m or 100 m transect (100 points per transect). The length of the transect will depend on the size of the assessment area. In some instances, cover may be measured using a point frame. This method is similar to the point intercept method except that the sample points are measured within a quadrat (usually 1 square-meter or 0.25 m2) rather than along a transect.

Plant Vigor: This assessment tool was used as part of the North Latitude Revegetation and Seed Project study the Alaska Plant Materials Center (APMC) initiated in 1987 (Wright, 1990). Plant vigor was subjectively ranked from 1–9, using the following criteria: plant tissue color, height, flower and/or seed production, and on overall health. This ranking system may also be used for

assessing the vigor of species in revegetated areas, although a more systematic ranking system is recommended to ensure consistency in assessments and data collection among observers.

Monitoring Schedule: Soil characteristics will be measured during the first year of seeding (or transplanting) and then every 3 to 5 years, depending on the vegetation response following treatment. Monitoring will no longer be conducted after an area fulfills the performance standards developed for the unit.

4.5 Remediation and Reclamation Research

This remediation plan is focused on actions that are immediately implementable to address ongoing remediation needs. A number of potential actions were identified in the risk management workshop to address areas of uncertainty related to remediation. These are shown in Table 1 under the heading "Uncertainty Reduction", and will be considered for further study in the uncertainty reduction plan, as indicated in Table 3. Issues identified from monitoring programs conducted by Teck and other members of the Ikayuqtit Team stakeholder group will also be considered for further study as part of the uncertainty reduction plan. Research topics for remediation and reclamation will be shared with the Ikayuqtit technical workgroup.

4.5.1 Tundra Remediation Research

Although spills in tundra will be addressed immediately (as discussed in Section 4.1), tundra areas will not be addressed by the threshold-based remediation approach (Section 4.2) at this time because it may not be the most scientifically sound way of ensuring recovery that resembles the tundra biome. Instead, remediation and reclamation research that will be conducted as part of the uncertainty reduction plan will focus on ensuring the most effective recovery for areas of concern.

One reason for not applying threshold-based remediation is that in Alaska, relying on secondary succession for tundra regeneration is gaining acceptance (Forbes and McKendrick 2002). In some situations, secondary succession results in the most natural-appearing and functioning type

of plant cover (Forbes and McKendrick 2002). Leaving damaged sites with a soil that resembles the natural landscape in topography, hydrology and other physical and chemical properties may be one of the most important practices for tundra rehabilitation.

In contrast, active removal of protective vegetation and organic soil/mat in areas with ice-rich soil permafrost can result in thermokarsting, permanently altered hydrologic regimes, and associated changes in plant communities, which may persist for decades (Conn et al. 2001). In areas of ice-rich permafrost, recovery from disturbance can slow, because soils and hydrology are disturbed by thermokarst and erosion. Chapin and Chapin (1980, as cited by Cargill and Chapin 1987) suggested that in tussock tundra, the organic mats contain buried seed that is sufficient to completely revegetate disturbed sites, so that productivity has been noted to return to that of undisturbed tundra within 10 years.

Vavrek et al. (1999) studied recovery of tundra vegetation in Alaska at a site that was bulldozed (Eagle Creek), a site that was burned (Mile Marker 107 Elliott Highway), and a control site. After 20 years, the burned site had returned to its pre-burn conditions, while the bulldozed plots were predicted to take several more decades. Vavrek et al. (1999) suggested that the removal of rhizomatous species slowed recovery in the bulldozed plots. The study results showed that methods of revegetation that involve removal of the organic layers and the vegetative soils layers should most likely be avoided.

Application of fertilizers or other agents may promote recovery of native vegetation, including mosses and lichens. McKendrick (1999) suggested that fertilization is very effective in tundra vegetation recovery, promoting moss regeneration within a single growing season. Biomass production, sexual and vegetative reproduction, and overall vigor of surviving plants and new recruits are improved with fertilizing (McKendrick 1999). As a result, as desirable soil conditions are established, plant restoration becomes a matter of allowing sufficient time for natural succession to proceed (Forbes and McKendrick 2002).

Thus, in general, care will be taken to avoid disturbing tundra areas surrounding the DMTS and mine facilities. Treatment methods for promoting vegetation recovery will be researched as part of the uncertainty reduction plan. Past research described in Section 3.1.5 will help inform and

guide future efforts. Additional methods of tundra remediation will be evaluated. In addition, a study aimed to better understand the nature and timing of natural tundra recovery after metals dust deposition has been decreased will also be considered in the uncertainty reduction plan.

4.6 Communication and Collaboration

In this section the standard communication guidelines developed in the communication plan (Exponent 2009) are applied to remediation. As with other programs, the remediation plan and associated remediation activities will have planning, implementation, and reporting stages. At each stage, communication actions have been identified that address the three categories of communication-related actions identified in the communication plan: collaboration, communication, and education and outreach. Table 4 provides a matrix summarizing the types of actions identified for the remediation plan and related activities to address the three communication categories at each stage.

The communication tools identified in Table 4 have been further developed in Table 5 to identify the specific actions expected to be necessary to accomplish the goals of the remediation plan. This list of actions draws from each of the three communication-related categories identified earlier in the plan (i.e., communication, collaboration, and education/outreach) and provides a set of actions that meet the goal of effectively communicating ongoing issues and efforts related to worker dust protection. Figure 1 illustrates important milestones in the development of the remediation plan, and provides the specific communication actions to be implemented.

4.6.1 Technical and Public Review

As described in the communication plan, the Ikayuqtit Technical Review Team has been expanded to incorporate other existing stakeholder representatives/groups and to serve as the technical review committee for fugitive dust-related studies and reports. Through the Ikayuqtit Team technical workgroup, stakeholders will provide technical review and input to the remediation plan and related study plans and reports at the planning, review, and reporting

stages. Following review by the team, a revised document incorporating team input will be made available for public review and comment. As described above among the actions to be implemented, remediation and related activities includes remediation (cleanup and reclamation), monitoring, and additional research. It is anticipated that a summary of spill cleanup activities and monitoring reports will be communicated to the Ikayuqtit technical team on an annual basis. Results of remediation-related research will be provided to the Ikayuqtit technical team for review when the result and reports are completed. A more detailed description of the review process for monitoring activities is provided in the monitoring plan, and more detail for additional research studies will be provided in the uncertainty reduction plan.

4.6.2 Community Meetings

Teck will continue to provide updates on remediation-related activities during regularly scheduled community meetings. Face-to-face meetings foster positive working relationships and provide a forum for soliciting local traditional ecological knowledge for incorporation into study planning and design. Strategies for improving adequate and representative participation in community meetings will be incorporated, including: 1) maintaining a regular and predictable schedule of meetings, 2) improving use of community liaisons to identify potential scheduling conflicts, 3) improving awareness of meetings (e.g., use of additional venues for written notices and/or announcements, improved e-mail lists, early advertisement of meetings), 4) facilitating active participation by using appropriate language and terminology, using translators, and providing information and opportunities for input using varied formats (formal presentations, informal discussions, small workgroups, written materials and questionnaires, etc.), and 5) providing effective, timely follow-up summarizing the input provided and how it will be incorporated and/or addressed.

4.6.3 Web Portal and Email Lists

Teck has established an information-sharing portal to provide access and/or links to fugitive dust-related studies, reports, and other information. The purpose of the portal is to facilitate collaborative development, review, and reporting of studies, remediation activities, monitoring

programs, and dust control efforts with stakeholders on the expanded Ikayuqtit Team. Thus, the web portal will be used to facilitate and coordinate technical review of remediation-related plans and reports. When documents are finalized and/or ready for full public review, they will be made available on the open access Red Dog website (www.RedDogAlaska.com). Teck will work with state agencies to ensure accessibility of remediation-related documents for public access and review, and provide links from the web portal and the Red Dog website where appropriate. Associated with this effort, Teck has expanded and will continue to update e-mail lists and use them to notify stakeholders of additions and/or revisions to the web portal, or when review and input is needed. Overall, this approach builds in several improved information sharing strategies that were identified as part of the RMP stakeholder workshop process.

4.6.4 Written Technical Communications

In the annual fugitive dust RMP report, Teck will include a brief summary of the prior year's remediation-related activities, and planned programs for the upcoming year. A simplified summary will be included at the front of the document to facilitate better understanding of the technical information. If necessary, a separate "fact sheet" summary may be developed.

4.6.5 Education and Outreach

Education and outreach actions include those activities that are related to, but outside the immediate scope of, remediation activities. They are focused toward providing additional opportunities for stakeholders to gain more understanding and participation in Red Dog operations as a whole, and health and environmental efforts in particular. Several education and outreach actions were proposed by stakeholders during the RMP process. The following actions have been identified as achievable for remediation efforts:

- Train and include local resident employees in remediation-related activities
- Provide updates and information on remediation-related activities as part of KOTZ radio updates and newsletter articles (e.g., highlighting results of tundra restoration efforts in remediated areas in a newsletter article).

5 Periodic Review and Reporting

Annual review of the remediation plan will involve the following tasks:

1. Review of the effectiveness of plan actions at meeting the stated goal of the plan.
2. Review of the effectiveness of communication, collaboration, and education efforts associated with the plan.
3. Revision of the remediation plan, as appropriate.

Communication efforts associated with the periodic review process will include:

- Notice of the timing and scope of the review, along with an invitation to stakeholders to provide input
- Communication of the results of the review process to stakeholders
- If substantial revisions are made to the remediation plan, a formal external review process will be considered, including release of a draft revised remediation plan. In most years the degree of modification needed is expected to be limited, and thus a formal external review process will not typically be warranted.
- General comments and input will be welcomed on an ongoing basis.

6 Milestones

Important milestones for the remediation plan include:

- Scope and goal of plan: August 2008 (provided within the draft RMP)
- Stakeholder technical review: October 2009 (completed)
- Public review draft release: June 2010
- Comment period ends for public review draft: July 2010
- Final draft release: August 2010
- Annual report and review: Spring 2011 as part of annual fugitive dust risk management report.

7 Stakeholder Roles

Stakeholder involvement is described in Section 4.6, *Communication and Collaboration*. Review of the draft remediation plan will be invited from all stakeholders and from the public as outlined in Section 6, *Milestones*, and in the flowchart shown in Figure 1. After the plan has been completed, future periodic review and input will also be welcomed, as indicated in Figure 1.

8 References

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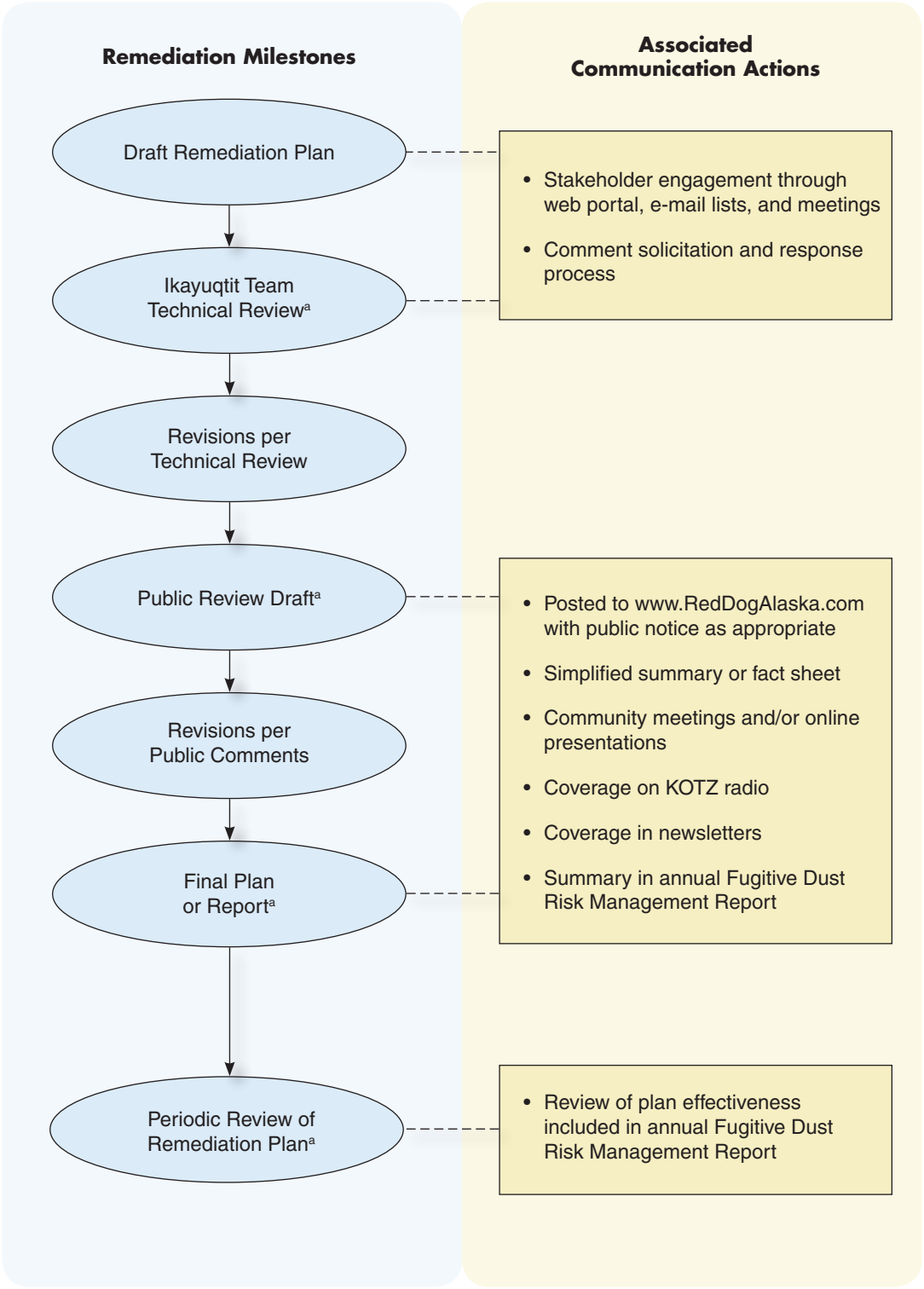
Figure 1
Remediation plan and report development flowchart



[a] Stages where regulatory input and review will be solicited

Figure 1. Remediation plan and report development flowchart illustrating associated communication actions

Tables

Table 1. Priority ranking of potential remediation actions identified in the risk management workshop

Potential Actions[a]	Priority Ranking
Remediation and Reclamation	
Define decision criteria to determine if tundra areas should be remediated or allowed to recover naturally[b]	1
Remediate hot spots that contribute to exposure, such as former truck spill areas	2
Define areas based on concentrations and/or degree of effects	2
Use biosolids for rehabilitating soils	NF[c]
Monitoring	
Monitor remediated or reclaimed areas to ensure long-term effectiveness	1
Communication	
Use traditional ecological knowledge to select culturally important areas for remediation	1
Share short- and long-term goals with stakeholders	1
Institutional Controls	
Place signage in remediated areas to prevent impacts during recovery process	2
Uncertainty Reduction	
Conduct pilot studies to evaluate tundra rehabilitation methods	3
Study the natural progression of grasslands into tundra to evaluate the potential for natural recovery following reclamation	3
Evaluate bioremediation to remove metals from surface soil or tundra	NF
Evaluate phytoremediation for removal of metals from soil	3
Develop predictive tools to predict when and where remediation will be needed	2

[a] Potential actions identified in the risk management workshop were scored based on effectiveness, implementability, level of effort, stakeholder preference for the action category, and stakeholder preference for the potential action. Scores for the five criteria were summed and a priority ranking between 1 and 3 was assigned based on total score. Potential actions assigned an NF were determined not to be feasible and are not carried further in the Remediation Plan. Details are provided in the Risk Management Plan.

[b] Incorporates the action "Define decision criteria for determining when remediation benefits outweigh the negative aspects of removing tundra habitat," which was previously listed separately in the RMP.

[c] Not Feasible

Table 2. Examples of remediation actions

Potential Actions	Remediation Action	Monitoring Action	Uncertainty Reduction Action	Communication Action	Source
Define decision criteria to determine if tundra areas should be remediated or allowed to recover naturally	X		X		RMP
Remediate hot spots that contribute to exposure, such as former truck spill areas	X				RDEO/ RMP
Define areas based on concentrations and/or degree of effects	X				RMP
Conduct pilot studies to evaluate tundra rehabilitation methods	X		X		RMP
Study the natural progression of grasslands into tundra to evaluate the potential for natural recovery following reclamation	X		X		RMP
Evaluate phytoremediation for removal of metals from soil	X				RMP
Conduct evaulation and remediation of road and facility areas with metals concentrations above defined cleanup levels	X				RDEO
Develop predictive tools to predict when and where remediation will be needed	X		X		RMP
Monitor remediated or reclaimed areas to ensure long-term effectiveness		X			RMP
Share short- and long-term goals with stakeholders				X	RMP
Use traditional ecological knowledge to select culturally important areas for remediation				X	RMP
Place signage in remediated areas to prevent impacts during recovery process	X			X	RMP

Note: RDEO - Red Dog Environmental Operations
RMP - Fugitive Dust Risk Management Plan

Table 3. Screening of potential actions for the remediation plan

Potential Actions	Retained (Y/N)	Comments and/or Rationale for Not Retaining the Action
Define decision criteria to determine if tundra areas should be remediated or allowed to recover naturally	Yes	
Remediate hot spots that contribute to exposure, such as former truck spill areas	Yes	
Define areas based on concentrations and/or degree of effects	Yes	
Conduct evaluation and remediation of road and facility areas with metals concentrations above defined cleanup levels	Yes	
Monitor remediated or reclaimed areas to ensure long-term effectiveness	Yes	
Share short- and long-term goals with stakeholders	Yes	
Use traditional ecological knowledge to select culturally important areas for remediation	Yes	
Place signage in remediated areas to prevent impacts during recovery process	Yes	
Conduct pilot studies to evaluate tundra rehabilitation methods	No	Will be considered in the Uncertainty Reduction Plan
Study the natural progression of grasslands into tundra to evaluate the potential for natural recovery following reclamation	No	Will be considered in the Uncertainty Reduction Plan
Evaluate phytoremediation for removal of metals from soil	No	Will be considered in the Uncertainty Reduction Plan
Develop predictive tools to predict when and where remediation will be needed	No	Will be considered in the Uncertainty Reduction Plan

Table 4. Communication elements and potential actions used in remediation-related activities

	Options Available at Various Program Stages		
	Planning	Implementation	Review and Reporting
Collaboration (Working together as a team)			
Ikayuqtit technical review	X		X
Community meetings	X		
Web portal and Red Dog website	X		X
E-mail list	X		X
Comment solicitation and response process	X		X
Train local resident employees for program	X	X	X
Communication (Providing information)			
Community meetings	X	X	X
Web portal and Red Dog website	X	X	X
E-mail list	X		X
Radio broadcasts and announcements	X		X
Technical reports			X
Annual summary			X
Report summaries and fact sheets			X
Education and Outreach			
Web portal and website	X		X
Train local resident employees for program	X	X	X
Newsletter articles			X
Radio broadcasts			X

Table 5. Remediation plan actions

Actions	Planned Timeline for Implementation	Purpose
Remediation and Reclamation		
1) Spill response remediation	Ongoing	Criteria and procedures to immediately address significant sources of metals dust resulting from spills.
2) Threshold dependent remediation	Ongoing	Maintain concentrations on facility surface areas below threshold levels to minimize fugitive metals dust.
3) Remediation conducted at closure	At Closure	To achieve cleanup goals defined in the reclamation and closure plan.
4) Remediation and reclamation research	Ongoing	To improve future remediation and reclamation efforts.
Monitoring		
1) Monitoring of remediated areas	Ongoing	Provides ongoing feedback on the effectiveness of the remediation actions and information to improve future remediation and reclamation efforts.
Communication and Collaboration		
Technical Review		
1) Use the expanded Ikayuqtit Team for technical review of remediation-related plans and reports at the planning, reporting, and review stages.		Creates a clear process for technical review using existing structures.
2) Implement public review process (illustrated in Figure 1).		Provides a means to incorporate local traditional ecological knowledge into study planning and design. Identifies which stakeholder group technical review is appropriate for which activities.
Community Meetings		
1) Provide updates on remediaton activities during regularly scheduled community meetings.		Forum for soliciting local traditional ecological knowledge for incorporation into study planning and design, including selection of areas for remediation. Increases trust and positive working relationships.
Web Portal and E-mail Lists		
1) Use the newly created e-Project web portal to facilitate and coordinate technical review of remediation-related plans and reports.		Creates a single clearinghouse for access to all Red Dog environmental-related documents, work plans, studies, and data.
2) Provide access to remediation-related plans and reports on the Red Dog website when they are finalized and/or ready for full public review.		Increases knowledge of both the existence of new information and access to that information.
3) Provide access to other relevant remediation information through links on the Red Dog website.		

Table 5. (cont.)

Actions	Planned Timeline for Implementation	Purpose
Written Technical Communications		
1) Include a summary of prior-year remediation activities and planned remediation for the upcoming year in the annual report (described in the Communication Plan).		Summarizes in one place yearly accomplishments and activities and plans for the future.
2) Provide a simplified summary or fact sheet for all remediation-related reports to facilitate better comprehension of the technical information.		Provides sense of continuity and communicates how information gained from past activities is used to develop future actions. Facilitates better understanding of technical information, and thus, more stakeholder involvement.
Education and Outreach		
1) Train local resident employees in remediation-related activities.		Activities related to, but often outside the immediate scope of standard Red Dog Environmental Operations. Helps ensure collaboration between stakeholders and use of traditional ecological knowledge as part of remediation program.
2) Provide updates and information related to remediation as part of KOTZ radio updates and newsletter articles (described in Communication Plan).		
3) Develop a timeline of remediation conducted in the past, ongoing activities, and future remediation plans.		